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Morphological properties of tunnel valleys beneath the southern sector of the former Laurentide Ice Sheet

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Tunnel valleys have been widely reported on the bed of former ice sheets and are considered an important expression of subglacial meltwater drainage. Although known to have been cut by erosive meltwater flow, the water source and development of channels has been widely debated. Possible mechanisms include: (i) gradual formation by water flow in a subglacially deforming bed into channels under steady-state conditions; (ii) time-transgressive formation close to the ice margin by drainage of supraglacial meltwater to the bed or of meltwater temporarily impounded behind a permafrost wedge; and or (iii) by catastrophic subglacial meltwater floods.

We have mapped and analysed the spatial pattern and morphometry of tunnel valleys and associated glacial bedforms along the southern sector of the former Laurentide Ice Sheet from high-resolution digital elevation models. Around 2000 tunnel valleys have been mapped, revealing a well-organised pattern of sub-parallel, semi-regularly spaced valleys that cluster together in distinctive networks. The tunnel valleys are typically <20 km long, and 0.5-3 km wide and preferentially terminate at moraines. They tend to be associated with outwash fans, eskers, glacial curvilineations, giant current ripples, and hill-hole-pairs. A relative age of the tunnel valleys, based on cross-cutting relationships, is used to resolve when individual tunnel valleys and networks were eroded. Our results suggest a time-transgressive origin for most tunnel valleys (i.e. they grow upstream) with some contributions from large meltwater drainage events.